

WHAT IS CLAIMED IS:

1. A method to minimize NO_x and UHC emissions in a pilot fuel ignited gaseous fuel engine comprising the steps:
 - determining a minimum amount of pilot fuel needed to ignite gaseous fuel in a combustion chamber;
 - injecting the pilot fuel into at least one of a prechamber and the combustion chamber;
 - determining a start of combustion location from one of an ionization signal and a cylinder pressure of the combustion chamber;
 - comparing the start of combustion location to a desired start of combustion location;
 - and
 - adjusting a pilot fuel injection timing if the start of combustion location is not approximately equal to the desired start of combustion location.
2. The method of claim 1 further comprising the step of measuring at least one of the ionization signal and the cylinder pressure of the combustion chamber.
3. The method of claim 1 wherein the pilot fuel is one of diesel fuel and engine oil.
4. The method of claim 1 further comprising the step of determining the desired start of combustion location.
5. The method of claim 1 further comprising the step of determining a pilot fuel injection timing.
6. The method of claim 5 wherein the step of determining the pilot fuel injection timing comprises determining the pilot fuel injection timing as a function of air/fuel ratio, engine speed, knock level, and exhaust gas oxygen concentration level.
7. The method of claim 1 further comprising the step of measuring the one of the ionization signal and the cylinder pressure.
8. The method of claim 1 further comprising the step of adjusting one of the pilot fuel amount and a pilot fuel injection timing if a misfire has occurred.

9. The method of claim 1 further comprising the step of adjusting one of the pilot fuel amount and a pilot fuel injection timing if a knock has occurred.
10. The method of claim 1 further comprising the steps of:
 - comparing a combustion quality measure to a desired value; and
 - adjusting the pilot fuel amount if the combustion quality measure is not approximately equal to the desired value.
11. A pilot fuel injection system controller comprising:
 - means for determining a minimum amount of pilot fuel needed to initiate combustion of gaseous fuel in a combustion chamber;
 - means for controlling a pilot fuel injector to inject the pilot fuel into at least one of a prechamber and the combustion chamber;
 - means for determining a start of combustion location from one of an ionization signal and a cylinder pressure;
 - means for comparing the start of combustion location to a desired start of combustion location; and
 - means for adjusting a pilot fuel injection timing if the start of combustion location is not approximately equal to the desired start of combustion location.
12. The pilot fuel injection system controller of claim 11 further comprising means for adjusting at least one of the pilot fuel amount and a pilot fuel injection timing if at least one of a knock has occurred and a misfire has occurred.
13. The pilot fuel injection system controller of claim 11 further comprising means for comparing a combustion quality measure to a desired value and adjusting the pilot fuel amount if the combustion quality measure is not approximately equal to the desired value.
14. A natural gas combustion engine comprising:
 - at least one cylinder having a combustion chamber;
 - a pilot fuel injector system comprising:
 - a pilot fuel injector in communication with the combustion chamber;
 - a controller for controlling the pilot fuel injector to minimize NO_x and UHC emissions, the controller including
 - means for determining a minimum amount of pilot fuel needed to initiate combustion of gaseous fuel in a combustion chamber;

means for controlling a pilot fuel injector to inject the pilot fuel into at least one of a prechamber and the combustion chamber;

means for determining a start of combustion location from one of an ionization signal and a cylinder pressure;

means for comparing the start of combustion location to a desired start of combustion location; and

means for adjusting a pilot fuel injection timing if the start of combustion location is not approximately equal to the desired start of combustion location.

15. The natural gas combustion engine of claim 14 wherein the controller further comprises means for adjusting the pilot fuel amount if at least one of a knock has occurred and a misfire has occurred.

16. The natural gas combustion engine of claim 14 wherein the controller further comprises means for adjusting a pilot fuel injection timing if at least one of a knock has occurred and a misfire has occurred.

17. The natural gas combustion engine of claim 14 wherein the controller further comprises means for adjusting the pilot fuel amount if the combustion quality measure is not approximately equal to a desired combustion quality.